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**Amendments to the Specification:**

Please replace paragraph 0011 with the following rewritten paragraph:

-- While such combination differential and absolute pressure transducer was a significant improvement over previous load lock control systems, it still had problems. For example, modern load lock pressures reach  $10^{-4}$  torr or less, and the traditional Pirani absolute pressure sensor used in the preferred embodiment of that system is not able to provide accurate and repeatable readings in such low pressures, e.g., below about  $10^{-3}$  torr. Such traditional convection Pirani sensors also have a flat zone in a range of about 10 to 100 torr, in which accuracy is low. While a flat zone in that pressure range does not affect door control operations by the transducer, which occur at other pressures as described above, it does interfere with other pressure monitoring and control functions, such as switching from slower load lock chamber pump-down rate in high-pressure regions to faster pump-down rate in low-pressure regions. Such switching usually is set to occur at some desired set point in a range between about 0.1 torr and about 10 torr, because fast pump down at higher pressures causes turbulence that can stir up particles and contaminant wafers. Conventional Pirani sensors also do not respond as fast to pressure changes as desired for controlling such switching from slow or "roughing" to fast or "turbo" rates. Also, accurate readings of pressure is always important for a variety of reasons. For example, if the pressure gauge is reading high, it takes longer to reach the set point, thereby reducing through-put of products. If it reads low, it can lead to potential contamination problems. --

Please replace paragraph 0016 with the following rewritten paragraph:

-- To achieve the foregoing and other objects, the apparatus of the present invention may comprise, but is not limited to, a combination differential and absolute pressure transducer apparatus for controlling a load lock that facilitates transfer of parts between a room at ambient atmospheric pressure and a vacuum processing chamber maintained at a pressure less than one (1) torr and that has an evacuable load lock chamber, an exterior door positioned between the load lock chamber and the room, an interior door positioned between the load lock chamber and the processing chamber, an exterior door actuator that is

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responsive to an exterior door control signal to open or close the exterior door, an interior door actuator that is responsive to an interior door control signal to open or close the interior door, and a vacuum pump connected to the load lock chamber for evacuating the load lock chamber. A slowing pump control device, such as a two-stage valve, can be installed between the vacuum pump and the load lock chamber. The combination differential and absolute pressure transducer has a differential pressure sensor that is capable of sensing a pressure difference between ambient atmospheric pressure in the room and pressure in the load lock chamber, and it has an absolute pressure sensor that is capable of sensing absolute pressure in the load lock chamber. The differential pressure sensor is mounted so that a first side of the differential pressure sensor is exposed to ambient atmospheric pressure in the room and so that a second side of the differential pressure is exposed to pressure in the load lock chamber. The absolute pressure sensor is also mounted so that it is exposed to pressure in the load lock chamber. Both the differential pressure sensor and the absolute pressure sensor can be connected in fluid flow relation to the load lock chamber by a common manifold. A differential pressure transducer circuit is connected to the differential pressure sensor and is capable of generating an exterior door control signal at a preset differential pressure value, and an absolute pressure transducer circuit is connected to the absolute pressure sensor and is capable of generating an interior door control signal at a preset absolute pressure value. An exterior door control link connected between the differential pressure transducer circuit and the exterior door is capable of delivering exterior door control signals generated by the differential pressure transducer circuit to the exterior door actuator; an interior door control link connected between the absolute pressure transducer and the interior door is capable of delivering interior door control signals generated by the absolute pressure transducer circuit to the interior door actuator. These links can be any of a variety of devices for transmitting ~~signal~~ signals, such as a wire or wires, infrared transmitter and receiver, and the like, and can include appropriate input/output components, amplifiers, and other devices as would be understood by persons skilled in the art, once they understand the principles of this invention. --

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Please replace paragraph 0017 with the following rewritten paragraph: --

-- The absolute pressure sensor preferably comprises a ~~micropirani~~ micropirani sensor with a resistivity that varies as a function of the pressure (heat exchange between a hot filament and a cooler environment) in the load lock chamber, and the absolute pressure transducer circuit can include a micropirani bridge circuit that incorporates the micropirani sensor resistive elements in the bridge circuit, which provides a signal voltage that varies as pressure in the load lock varies. A secondary temperature compensation circuit uses a resistive element on the micropirani sensor, preferably fabricated on the same substrate, but that is not exposed to load lock pressure to correct for variations in the bridge output signal that occur due to temperature changes as opposed to absolute pressure changes in the load lock. Placing this resistive element on the same substrate improves temperature compensation accuracy and response time. An analog process circuit connected to the micropirani bridge circuit conditions, amplifies, and adjusts the signal voltage from the bridge circuit for use in controlling the opening of the interior door between the load lock and the process chamber, and it includes zero and full scale adjustment features. It also produces an auxiliary output signal that is amplified even more for use especially in low pressure ranges where the regular output signal may be too weak to use accurately and dependably. A relay control circuit uses the conditioned, amplified, and adjusted voltage to generate an interior door control signal when such voltage is at a value that corresponds with a set point absolute pressure value, which can be adjusted. Hysteresis is also provided to prevent dithering and chattering of the relay at or near set point pressure. --

Please replace paragraph 0018 with the following rewritten paragraph:

-- The differential pressure sensor preferably comprises a thin film diaphragm piezo semiconductor pressure sensor in which a thin film diaphragm is positioned with the load lock chamber pressure on one side of the diaphragm and ambient atmospheric pressure of the room on another side of the diaphragm so that the diaphragm flexes one way or the other, with the direction and magnitude of such flexing dependent on the direction and magnitude of the differential pressure across the diaphragm. Resistivity of piezo semiconductor

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elements (preferably polysilicon resistors) varies as a function of differential pressure across a diaphragm. An analog process circuit conditions, amplifies, and adjusts the signal voltage from the bridge circuit to a more usable signal. A relay control circuit monitors the voltage from the analog process circuit and generates the exterior door control signal when the voltage of the analog process circuit corresponds with the present differential pressure value. Set point differential pressure for actuating the relay and hysteresis for preventing dithering and chattering the relay at or near set point differential pressure is also provided. --

Please replace paragraph 0040 with the following rewritten paragraph:

-- A miniaturized pressure transducer assembly 10 according to this invention is shown in Figures 1 and 2 mounted on a load lock chamber 60. In general, the miniaturized pressure transducer assembly 10 comprises an absolute pressure sensor assembly 20 and a differential pressure sensor assembly 30, as best seen in Figure 2, each of which is connected in gas flow relationship to a common manifold 40. The manifold 40 has a connector 42, such as a conventional flanged pipe fitting 43, for connecting the manifold 40 to the load lock chamber 60, which will be discussed below. The connection is shown sealed with an O-ring seal 45 and secured with a clamp 47 in a conventional manner. A circuit board 12 with signal processing and control circuitry 80, which will be discussed in more detail below, is shown in Figure 2 with the absolute pressure sensor assembly 20 and the differential pressure sensor assembly 30 mounted on its bottom end. The circuit board 12 is mounted and fastened by a plurality of ~~screws~~ screws 13 to the manifold 40, with the screws 13 tightened to seal the pressure sensors 20, 30 to the top surface 41 of the manifold with O-ring seals 48, 49, respectively. A dust cover 14 surrounding and covering the circuit board 12 with the absolute pressure sensor assembly 20 and the differential pressure sensor assembly 30 is fastened by a screw 15 to the manifold 40. A 9-pin K1 connector 16 extends from the circuit board 12 through the housing 14 to accommodate connecting the circuit board 12 to an outside power source, to control actuators (not shown) for the load lock doors (discussed below), and the like via a power/data cord 18. --

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Please replace paragraph 0048 with the following rewritten paragraph: --

-- Referring now to Figures 2, 5, and 6, the manifold 40 serves as a mounting base for the circuit board 12, and the pressure sensor assemblies 20, ~~20~~ 30 are mounted on a panel 17 at the bottom of the circuit board 12 between the bottom of the circuit board 12 and the top surface 41 of the manifold 40. The manifold 40 has a body 44 with a top surface 41, bottom surface 51, and a cavity 50 that is open at the bottom surface 51 and extends upwardly toward, but not all the way to, the top surface 41. Two ducts 52, 54 extend from the cavity 50 to the top surface 41 in spatial alignment with the pressure sensor assemblies 20, 30, respectively. Therefore, when the manifold 40 is mounted on the load lock 60, as shown in Figure 2, the manifold 40 connects the pressure sensor assemblies 20, 30 into fluid flow relationship with the interior 61 of the load lock 60. --

Please replace paragraph 0049 with the following rewritten paragraph:

-- As mentioned above, the fastening screws 13 are tightened to snug the pressure sensors 20, ~~20~~ 30 against the top surface 41 with O-rings 48, 49, respectively sealing the pressure sensor assemblies 20, 30 to the top surface 41 around the ducts 52, 54, respectively. The absolute pressure sensor assembly 20 has a cylindrical housing 21 that is fastened to the bottom surface 19 of panel 17 and contains a micropirani absolute pressure sensor 110, which is exposed to the pressure in the interior 61 of the load lock 60 through an open bottom of the housing 21 (see Figure 7) via the duct 52 and cavity 50 in manifold 40. The absolute pressure sensor housing 21 is closed at its top, because the micropirani pressure sensor 110 is exposed only to the pressure in the interior 61 of the load lock 60 and not to atmospheric pressure. The micropirani sensor 100 will be described in more detail below. --

Please replace paragraph 0050 with the following rewritten paragraph:

-- The differential pressure sensor assembly 30 also has a cylindrical housing 31 that contains piezo differential pressure sensor 200, which is not shown in Figures 2 but is indicated by broken lines in ~~figure~~ Figure 7, because it is concealed by the bottom surface 32 of the housing 31. The piezo differential pressure sensor 200 will be described in more detail

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below. The housing 31 is mostly closed at its bottom surface 32 as best seen in Figure 7, but there is a hole 33 through the bottom surface 32, which exposes the bottom side of the piezo differential pressure sensor 200 to the pressure of the interior 61 of the load lock 60 via the duct 54 and cavity 50 of manifold 40, as best seen in Figure 2. The top side of the piezo differential pressure sensor 200 has to be exposed to ambient (atmospheric) pressure in order to sense the difference between the atmospheric pressure and the pressure of the interior 61 of the load lock 60, i.e., the differential pressure, as will be explained in more detail below. Therefore, the housing 31 does have an opening in its top (not shown) and is exposed to the atmosphere. A hole 34 through the bottom panel 17 of circuit board 12, as shown in broken lines in Figure 2, can be aligned with an opening (not shown) in the top of housing 31 to facilitate exposure of the top of the piezo differential pressure sensor 200 (not shown in Figure 2) to the atmosphere. --

Please replace paragraph 0052 with the following rewritten paragraph:

— An enlarged view of a preferred embodiment of the micropirani absolute pressure sensor 110 is shown in Figure 8. The main body 112 comprises a substrate 114 preferably fabricated with silicon (Si), and thin film components and resistive elements (not seen in Figure 8), which, when operative as explained in more detail below, provide a signal that is indicative of absolute pressure to which it is exposed. Materials other than silicon will work for the substrate, but silicon is inexpensive, and deposition of other materials on silicon is a well-known field, thus conducive to keeping costs down. The resistive elements (not seen in Figure 8) terminate in metal contact pads 121, 122, 123, 124, 125, 126, 127, 128, preferably gold, which are exposed through the passivation (protective) layer 120, and respective leads 131, 132, 133, 134, 135, 136, 137, 138 are soldered to the contact pads 121 - 128 to connect the micropirani absolute pressure sensor 110 electronically to the circuit board panel 17, as best seen in Figure 7. The leads 131 - 138 connect to pins 141, 142, 143, 144, 145, 146, 147, 148, respectively, in the sensor assembly 20, as also best seen in Figure 7. The pins 141 - 148 connect by traces to circuit board pins 151, 152, 153, 154, 155, 156, 157, 158, respectively in the circuit board panel 17, and the circuit board pins 151 - 158 lead to the various electronic components of the circuit 80, as will be described in more detail below.

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Referring again to Figure 8, a cover 160 is mounted on the main body 112 to protect fragile thin film components (not seen in Figure 8), which will be described below. An opening 161 into a cavity 162 (not seen in Figure 8) in the cover 160 exposes the thin film components (not seen in Figure 8) in the body 112 to the pressure of the interior 61 of the load lock 60, as described above and shown in Figure 2. --

Please replace paragraph 0054 with the following rewritten paragraph:

-- Referring now to Figure 9, the main body 112 of the micropirani absolute pressure sensor 110 is shown partially constructed with a cavity 116 (shown in broken lines) etched into the substrate 114 and with a dielectric non-conductive film 117 of silicon nitride ( $\text{Si}_3\text{N}_4$ ) or silicon dioxide ( $\text{SiO}_2$ ) overlaying the substrate 114 to form a thin membrane 118 over the cavity 116. The membrane 118 has one or more holes 119 extending through the membrane 118 into the cavity 116 to provide free flow of gas molecules and equalization of pressure over and under the membrane 118. Two resistive elements or filaments 170, 172, preferably nickel (Ni), are deposited on the film dielectric 117, including ~~over~~ on the membrane 118. The resistive elements 170, 172 terminate at respective metal (preferably gold (Au)) contact pads 121, 122 and 123, 128. Two additional resistive elements 174, 176 are deposited on the dielectric film 117, but not on the membrane 118 portion of film 117, which are used for temperature compensation adjustments, as will be described in more detail below. The resistive elements 174, 176, preferably nickel (Ni), terminate at respective contact pads (preferably gold (Au)) 124, 125 and 126, 127. --

Please replace paragraph 0055 with the following rewritten paragraph:

-- As best seen in Figure 10, another passivation (protective) layer 120 of a dielectric material, such as  $\text{Si}_3\text{N}_4$  or  $\text{SiO}_2$ , is deposited over the first dielectric film 117 and over the resistive elements 170, 172, 174, 176. The portions of the dielectric layers 117, 120 and substrate 114 that are cut away reveal features of the structure for clarity of description only. As mentioned earlier, the contact pads 121 - 128 are left exposed so that leads 131 - 138 (Figure 8) can be soldered to them. ~~The cover 160, as~~ As revealed by the cut-away portion in Figure 10, the cover 160 has a cavity 162 sized about the same as the cavity 116 in the

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substrate 114 and the hole 161 extending through a sidewall 163 of the cover-into the cavity 162. The cover, which can also be made of silicon (Si) is positioned on the main body 112 with the cavities 116, 162 juxtaposed in relation to each other on opposite sides of the membrane 118. --

Please replace paragraph 0056 with the following rewritten paragraph:

-- In this application, the two resistive elements 170, 172 can be connected together, preferably in series, but possibly in parallel, to function as a single resistive element. Such connection can be done in the electric circuit 80. In operation, a voltage is applied across the resistive elements 170, 172 to flow an electric current through the resistive elements ~~180~~ 170, 172, which is monitored with a bridge circuit 90 (Figures 4 and 16), as will be described in more detail below. The electric current flowing through the resistive elements 170, 172 creates heat that has to be dissipated. Some of the heat from the resistive elements dissipates by radiation, but some also is conducted away by gas molecules in the cavities 116, 162. The higher the pressure in the cavities 116, 162, the more molecules there will be to conduct heat away from the resistive elements 170, 172. Conversely, the less pressure in cavities 116, 162, the fewer gas molecules to conduct away heat. The miniature cavities 116, 162 and the thin film membrane 118 in which the resistive elements are embedded between the cavities has several advantages for this application. For example, the thin film membrane 118 leaves very little material between the resistive elements 170, 172 and gas molecules in the cavities 116, 162, so heat transfer from the resistive elements 170, 172 to the gas molecules in cavities 116, 162 is not impeded. At the same time, the thin film membrane 118 does not conduct heat laterally to the bulky silicon body 112 of the sensor very rapidly, so heat dissipation from the resistive elements 170, 172 is driven more by the gas molecules in the cavities 116, 162, which is pressure dependent, than by lateral heat conduction through the membrane 118 to the body 112, which is not pressure dependent. Therefore, heat conduction away from the resistive elements or filaments ~~70~~ 170, 72 ~~172~~ is very responsive to changes in pressure in the cavities 116, 162. --



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Please replace paragraph 0057 with the following rewritten paragraph: -

-- A thermal boundary layer forms around a hot filament, the thickness of which is about ten to fifty times the mean free path of the gas molecules (statistical distance gas molecules travel between collisions). Higher pressures have higher gas densities, thus more gas molecules, which provides shorter mean free path. If the distance  $d$  between the hot filament surface to the colder surroundings is made larger than the thermal boundary layer thickness, the change of room temperature or sensor temperature will have less effect on the ~~temperature~~ sensor output, which is the reason for the undesirable flat zone in a conventional pirani and ~~conventional~~ convection gauge gauges. However, because the cavities 116, 162 in the micropirani sensor 110 are small (about 20  $\mu\text{m}$  deep), i.e., less than the thermal boundary layer to avoid the undesirable flat zones mentioned above, it has much better sensitivity at high-pressure regions. Also, the small cavities 116, 162 with only small openings 161 and 119 change pressure simultaneously with pressure changes outside the cavities 116, 162 while virtually preventing convection currents of gas molecules in the cavities 116, 162, which would otherwise affect heat conduction, thus the accuracy and repeatability of the output signals as a function of pressure changes. Also, the small cavities 116, 162 provide a small gap between the heat source (resistive elements 170, ~~170, 172~~) and the heat sink (main body 112 and cover 160), e.g., about 20  $\mu\text{m}$  as mentioned above, which improves heat transfer by gas conduction, thus sensor sensitivity to pressure changes at the higher end, e.g., about 1 to 1000 torr range. --

Please replace paragraph 0058 with the following rewritten paragraph:

-- As heat is conducted away from the resistive elements or filaments ~~70, 170, 72, 172~~ they cool, and cooler filaments ~~70 170, 72, 172~~ have less resistance to current flow than hotter filaments ~~70 170, 72 172~~. Therefore, changes in pressure in the interior 61 of load lock 60, thus changes in pressure in cavities ~~16 116, 62 162~~ of the micropirani absolute pressure sensor 110, cause changes in the bridge circuit 90 that are indicative of such pressure changes, as will be discussed in more detail below. Suffice it to say at this point that such changes in the bridge circuit 90 are detectable and used by the circuit 80 to produce control

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signals for load lock 60 doors 62, 64 and other load lock 60 components. The graph in Figure 11 shows an example raw signal voltage from a micropirani pressure sensor 110 for a range of absolute pressures. In this example, the signal voltage outputs range from 0.0001 volt to 10.0000 volts for absolute pressures ranging from 1.0E -05 to 1.0E +02 torr, i.e., from  $10^{-5}$  torr to 100 torr. While it is clear from this graph that the output voltage flattens out in the higher pressure regions, ~~accurated~~ accurate pressure readings are obtainable and useable at least as high as 1,000 torr from this micropirani sensor 110. --

Please replace paragraph 0061 with the following rewritten paragraph:

-- Suitable piezo differential pressure sensor 200 for use in this invention are manufactured by Motorola, Inc., of Northbrook, Illinois and by Honeywell, Inc., of Morristown, New Jersey, as well as a number of other manufacturers. Since such piezo differential pressure sensors are readily available commercially, it is not necessary to describe all of the details of how such a piezo differential pressure sensor is fabricated and functions. Therefore, only enough explanation is provided to understand how such a piezo differential pressure sensor 110 200 functions in this invention. --

Please replace paragraph 0063 with the following rewritten paragraph:

-- Referring now primarily to Figures 12, 13, and 14, the piezo differential pressure sensor 200 may comprise a main body 204, such as bulk silicon, with a cavity 206 etched into its bottom surface 202 and extending most of the way toward, but not all the way to, the top surface 201. One or more, preferably two, piezo resistive elements 210, 212 are implanted in a thin membrane portion 208 of the main body 204 that extends over the cavity 206. ~~The main body 204, including the membrane portion 208, and~~ The piezo resistive elements 210, 212 can be doped semiconductor materials that respond to flexure in the membrane portion 208 ~~by changing with changes in electrical resistivity of the resistive elements,~~ as is known to persons skilled in the art and which are available in commercial models of the piezo differential pressure sensor 110, as described above. Preferably, at least one, and more preferably two, additional piezo resistive elements 214, 216 are embedded in the main body ~~206~~ 204 adjacent, but not in, the membrane portion 208, so they do not flex when the

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membrane 208 and piezo resistive elements 210, 212 flex. The piezo resistive elements 210, 212, 214, 216 are connected by conductive traces 211, 213, 215, 217 to form a wheatstone bridge circuit. Conductive contacts 220, 222, 224, 226, preferably metal, such as gold, contact the respective piezo resistive elements 210, 212, 214, 216 and extend through a passivation film 209, such as silicon dioxide ( $\text{SiO}_2$ ) to the top surface 201, where they are exposed. Therefore, leads 230, 232, 234, 236 can be soldered to the respective contact pads 220, 222, 224, 226 for electrical connection to the electric circuit 80 (Figures 2 and 4). --

Please replace paragraph 0064 with the following rewritten paragraph:

-- As best seen in Figure 13, atmospheric pressure  $P_A$  is applied to the top surface 201 of the membrane portion 208, while pressure  $P_L$  of the interior 61 of the load lock 60 (Figure 3) is applied to the bottom surface 205 of the membrane portion 208. If the load lock pressure  $P_L$  is greater than the atmospheric pressure  $P_A$ , the membrane portion 208 will flex upwardly, as indicated by phantom line ~~208"~~ 208'. On the other, if the atmospheric pressure  $P_A$  is greater than the load lock pressure  $P_L$ , the membrane portion 208 will flex downwardly, as indicated by phantom line 208". If both the atmospheric pressure  $P_A$  and the load lock pressure are the same, i.e.,  $P_A = P_L$ , then there will be no flexure of the membrane portion 208. --

Please replace paragraph 0065 with the following rewritten paragraph:

-- As the membrane portion 208 flexes either upwardly or downwardly, the two piezo resistive elements 210, 212 embedded in the membrane portion 208 also flex with the membrane portion 208. Such flexure causes the piezo resistive elements 210, 212 to undergo proportional changes in electrical resistivity, which can be detected and used by the electric circuit 80 (Figures 2 and 4) to generate control signals for the outer load lock door 62 (Figure 3) at a preselected differential pressure, as will be explained in more detail below. The other two piezo resistive elements 214, 216, which are not in the membrane portion 108, do not flex, regardless of pressure differential between the atmospheric pressure  $P_A$  and the load lock pressure  $P_L$ . ~~therefore~~ Therefore, the piezo resistive elements 214, 216 provide reference voltages for use in the piezo bridge circuit 100 (Figure 4). Also, since these reference piezo resistive elements 214, 216 are mounted in the main body 204 adjacent the

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membrane 208, they are essentially at the same temperature as the piezo resistive elements 210, 212. Therefore, any change in resistivity of the piezo resistive elements 210, 212 due to changes in temperature will be offset by comparable changes in resistivity in the reference piezo resistive elements 214, 216. Consequently, the signal output of the piezo bridge circuit 100 is quite insensitive to temperature changes. The graph in Figure 15 shows an example of piezo output signal voltages for differential pressures ranging from about -28.00 torr to +28.00 torr. In that differential pressure range, the signal voltage is between 0.000 volts for -28.00 torr and 3.000 volts for about +28.00 28.00 torr, and, in that range, the voltage change to pressure change relationship is linear. --

Please replace paragraph 0066 with the following rewritten paragraph:

-- The leads 230, 232, 234, 236 are connected to the electric circuit board 12 by connection first to external pins 240, 242, 244, 246 extending from the side of the housing 31, as best seen in Figure 7. ~~these~~ Those external pins 240, 242, 244, 246 connect to traces in the bottom panel 17, which, in turn connect to pins 250, 252, 254, 256 that extend through bottom panel 17 to the main circuit board 12 (Figure 2). --

Please replace paragraph 0067 with the following rewritten paragraph:

-- A schematic diagram of the electric circuit 80 on the circuit board 12 (~~Figure~~ Figures 2 and 4) is shown in Figure 16 with portions of the circuit 80 that correspond to function blocks on Figure 4 outlined in broken lines in Figure 16, including the micropirani bridge circuit 90, secondary temperature compensation circuit 92, analog process circuit 93, relay control circuit 94, and vacuum switch relay 95, piezo bridge circuit 100, analog process circuit 102, relay control circuit 104, atmospheric switch relay 105, power supply 91, and connector 16 ~~outlined with broken lines~~. Persons skilled in the art will readily understand this electric circuit 80 from the functions and features described, but several salient features can be mentioned. The two resistive elements or filaments 170, 172 of the micropirani sensor 110 are shown in the micropirani bridge circuit 90, as is the one offset, temperature sensing, resistive element 174. ~~the~~ The bridge comprises essentially, the filaments 170, 172 together between voltage nodes G (ground) and V. --

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Please replace paragraph 0068 with the following rewritten paragraph: -

-- As pressure in the load lock chamber 60 (~~figure~~ Figure 3), thus gas pressure adjacent the filaments 170, 172, decreases, conduction of heat ~~by gas molecules~~ from the filaments 170, 172 ~~by gas molecules~~ decreases. ~~Such Decrease decrease~~ in heat dissipation from the filaments 170, 172 would, in the absence of an adjustment, cause temperature of the filaments 170, 172, thus resistance of the filaments 170, 172, to increase. ~~Such An an~~ increase in resistance of the ~~filament~~ filaments 170, 172 would change current flow in the bridge circuit 90 and cause the bridge voltages  $V_1$  and  $V_2$  to become unbalanced, i.e.,  $V_1$  would not equal  $V_2$ . ~~which~~ Such unbalanced condition between  $V_1$  and  $V_2$  is detected by a voltage comparator 178, which drives the voltage in the bridge circuit 90. In response, the transistor controller 180 in the bridge circuit 90 lowers the voltage  $V_0$  in the bridge circuit 90, which lowers the voltage  $V_F$  across the filaments 170, 172, thus lowers current flow  $I$  through the filaments 170, 172. ~~the~~ The lower current  $I$  in filaments 170, 172, lowers heat production in the filaments 170, 172, because production of heat requires power, and power equals  $I^2R$ . Less heat production means temperature of the filaments 170, 172 comes back down, thus resistance of the filaments 170, 172 comes back down, which readjusts current flow in the bridge circuit 90 back in balance, i.e.,  ~~$V_1 = V_2$~~   $V_1 = V_2$  again. --

Please replace paragraph 0069 with the following rewritten paragraph:

-- Conversely, when load lock chamber 60 pressure, thus pressure adjacent the filaments 170, 172, increases, more gas molecules conduct more heat away from the filaments 170, 172, which, in the absence of an adjustment, would lower temperature, thus resistance, of the filaments 170, 172. Lower resistance in filaments 170, 172 would change current flow in the bridge circuit 90, thus causing the bridge circuit 90 to become unbalanced, i.e.,  $V_1$  would not equal  $V_2$ . Again, such imbalance is detected by the voltage comparator circuit 178, which causes the transistor controller 180 to increase  $V_0$ . The increased  $V_0$  increases  $V_F$  across the filaments 170, 172 to increase current  $I$  in the filaments 170, 172, which increases power ( ~~$I_2R$~~   $I^2R$ ) to raise the temperature, thus resistance, of filaments 170, 172 to put the bridge circuit 90 back into balance, i.e.,  $V_1 = V_2$ . Consequently, with these adjustments of the voltage  $V_0$ ,

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the temperature of the filaments 170, 172 is kept constant. Further, such decreases and increases of the voltage  $V_0$  required to maintain the filaments 170, 172 temperature constant, as explained above, are indicative of changes in load lock chamber 60 pressure. --

Please replace paragraph 0070 with the following rewritten paragraph:

-- The voltage  $V_0$  can, therefore, with conditioning, amplification, and adjustment, as described below, be monitored electronically and used to actuate the relay control circuit 94 to generate and output a control signal on link 84 (Figures 3 and 4) to open the interior door 62, or to allow the interior door 62 to be opened, at some selected minimum load lock chamber 60 pressure level that matches or is near the pressure maintained in the process chamber 70. ~~optionally~~ Optionally, as mentioned above, the voltage  $V_0$  could also be used, after conditioning, amplification, and adjustment, to actuate the relay control circuit 94 or another relay control circuit (not shown) to generate and output a control signal on link 68 to the throttle valve 66 (Figures 3 and 4) to increase the effective pumping speed of the vacuum pump 65 after the load lock chamber 60 pressure is drawn down to some desired intermediate load lock chamber 60 pressure threshold. --

Please replace paragraph 0071 with the following rewritten paragraph:

-- Before the signal at the  $V_0$  node is used for the purposes described above, though, some conditioning, amplifying, and adjusting is helpful. The capacitor C24 and resistor R49 combination filters noise out of the  ~~$V_0$  signal~~  $V_0$  signal in the micropirani bridge circuit 90 prior to amplification in the analog process circuit 93. The resistors R51, R52, R53, R54 provide a capability to add resistors depending on characteristics of a particular ~~micropirani~~ micropirani sensor 110 (Figures 8 – 10). The fourth resistive element 176 of the micropirani sensor 110, which is not on the membrane 118 over the cavity 116 (Figures 9 – 10) is used along with a voltage comparator 182 in a secondary temperature compensation circuit 92, as shown in Figure 16, to adjust the  $V_0$  signal in a manner to compensate further for  $V_0$  levels that are due to changes in ambient temperature rather than changes in load lock pressure  $P_L$ . The precision voltage regulators 184, 186 provide precision reference voltages (REF 1 =

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+6.2 volts and REF 2 = -6.2 volts) for use by the voltage comparator 182 in the secondary temperature compensation circuit 92. --

Please replace paragraph 0072 with the following rewritten paragraph:

-- In the analog process circuit 93, and amplifier 188 amplifies the  $V_0$  signal from the micropirani bridge circuit 90, as adjusted by the secondary temperature compensation circuit 92, according to a formula  $Y = a + bx$ , where  $x$  is the secondary temperature compensated  $V_0$ ,  $a$  is the zero offset adjust as set at 187, and  $b$  is the full scale span adjust as set at 189. In other words, the zero offset 187 is adjustable manually to set the amplified micropirani signal voltage at the desired level to correspond with a particular absolute pressure  $P_L$  range, e.g., 0.0001 volt for  $10^{-5}$  torr to 10.000 volts for 760 torr, as shown in the chart of Figure 11. Therefore, the amplified micropirani signal at node or link ~~66~~ 96 in Figure 16, as illustrated in the Figure 11 chart, is indicative of absolute pressure  $P_L$  in the interior 61 of the load lock 60 (Figure 4) and is provided at output link 96 in circuit 80 (Figures 4 and 16) for use by external circuits and/or controllers, such as the absolute pressure monitor 98 (Figure 4), slow/turbo pump actuator 66, interior door actuator 62, and the like, as explained above. An auxiliary amplifier 190 in Figure 16 provides a further amplified signal, e.g., ten times the output signal of primary amplifier 188, on an auxiliary link 97 for use ~~1~~ in very low absolute pressure zones, such as below  $10^{-4}$  torr, where the primary amplified signal on link 96 from the primary amplifier 188 is too weak for accurate monitoring and use, as also explained above. The third link 99 from the analog process circuit feeds the primary amplified signal from the primary amplifier 188 to the relay control circuit 94 for use in operating the vacuum relay switch 95. --

Please replace paragraph 0073 with the following rewritten paragraph:

-- In the relay control circuit 94, an op amp 191 ~~used~~ uses the amplified absolute pressure signal on link 99 from the analog process circuit 93 to drive a transistor switch 192 to output an on or off signal to the vacuum switch relay 95, which can be used to operate the interior door 62 actuator (Figures 3 and 40) or the slow/turbo pump actuator 66 (Figures 3 and 4), as described above. However, before the absolute pressure signal on link 99 in Figure 16 is

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used by the op amp 191 for ~~the~~ that purpose, it is adjusted in several ways. First, there is a set point adjustment 193, as shown in Figure 16, which sets the absolute pressure at which the relay switch 95 is to be actuated. For example, if it is desired to use the relay switch 95 to operate the interior door 62 actuator (Figures 3 and 4) at, e.g.,  $10^{-4}$  torr, this set point adjustment 193 in Figure 16 can be used to set  $10^{-4}$  torr as the pressure at which the transistor 192 will operate the relay switch 95 to close the normally open (NO) contact 194 in vacuum relay switch 95 ~~So~~ to send an actuator signal to the interior door 62 actuator. Alternatively, if it is desired to use the relay switch 95 to operate the slow/turbo pump actuator 66 at, e.g., 1 torr, this set point adjustment 193 can be used to set 1 torr as the pressure at which the transistor 192 will operate the relay switch 95 to close the normally open (NO) contact 194 in vacuum relay switch 95 to send an actuator signal to the slow/turbo pump actuator 66. --

Please replace paragraph 0074 with the following rewritten paragraph:

-- A hysteresis adjustment 195 with a hysteresis circuit IC 196 can be used to set a hysteresis, i.e., pressure range around the set point pressure described above, in which the op amp 191 will drive the transistor 192 to deactuate the vacuum relay switch 95 after it has been actuated. For example, if the vacuum relay switch 95 is set to actuate the turbo pump mode at 1 torr, as discussed above, the hysteresis adjustment 195 can be set so that the vacuum relay switch 95 will not be deactuated until the pressure rises to 5 torr, which prevents the op amp 191 and transistor 192 from dithering or chattering the vacuum relay switch on and off at or near the 1 torr set point. --

Please replace paragraph 0075 with the following rewritten paragraph:

-- The piezo differential pressure sensor 200, with its four resistive elements 210, 212, 214, 216 is shown schematically in circuit 80 in Figure ~~16~~ 16 as part of the piezo bridge circuit 100, whereby two of the resistive elements ~~210, 214~~ 210, 212, which are mounted in the flexible membrane 208 (Figures 12-14) increase with positive pressure or vice versa while two resistive elements ~~214, 216~~ 214, 216 decrease do not change, as described above. The resulting output voltage  ~~$V_0$~~   $V_0$  of the bridge circuit 100 in Figure 16 is indicative of the differential pressure across the membrane 208. The op amp 260 functions as a buffer and



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drives the voltage for the piezo bridge of elements 210, 212, 214, 216. Op amps 261, 262 determine voltage differences in the bridge points and output the piezo bridge signal on node 263, which is indicative of differential pressure between atmospheric pressure  $P_A$  and load lock pressure  $P_L$  ~~on node 263~~ across the membrane 208. In the analog process circuit 102 in Figure 16, the piezo bridge circuit output signal from node 263 is amplified by amplifier 270 for use in the relay control circuit 104. It is also zero adjusted at 271 to set the amplified voltage at which zero differential pressure is indicated at the amplifier output 272, e.g., 1.5 volts in the graph of Figure 15. The signal is also full scale adjusted at 273 to set the scale of the amplified signal over its span or range, e.g., 0.000 volts for -30 torr to 3.000 volts for +30 torr in the graph of Figure 15. These zero and full scale adjustments can be ~~make~~ made manually, as desired by an operator. The amplified voltage signal output at node 272 is the signal charted in Figure 15. The op amp 274 and potentiometer 275 are used for piezo temperature compensation. --

Please replace paragraph 0076 with the following rewritten paragraph:

-- The relay control circuit 104 for the atmospheric switch relay 105 of circuit 80 in Figure 16 functions in a similar manner to the relay control circuit 94 described above for the vacuum switch relay 95. The amplified piezo output signal at node 272 is used by op amp 280 to drive transistor switch 282 in "on" or "off" mode to actuate the atmosphere relay switch 105 to output a control signal for the exterior door 64 actuator, as described above and shown in Figures 3 and 4. This relay 105, as shown in Figure 16, has both a normally open (NO) contact and a normally closed (NC) contact, either ~~or~~ of which can be used for the output control signal to the exterior door 64 actuator, depending on how the exterior door 64 actuator is configured. Because of the limited number of connecting pins (nine) in the connector 16 illustrated in Figure 16, the circuit 80 has been arranged so that either the NO or the NC, but not both, can be provided at the connector 16. For example, if the NC mode is used, the resistor 283 has to be in place, and the resistor 197 in the auxiliary micropirani output link 97 of the micropirani analog process circuit 93 would have to be removed, because they cannot both be output on pin 6 of the connector 16 at the same time. Of course, there are many other options, such as a larger connector 16 with more connector pins could

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be used to output all of the signals simultaneously, or the NO and NC modes of the vacuum switch relay could be set up as alternatives on the pin 2 of connector 16, as would be within the capabilities of persons skilled in the art. The set point adjustment is used to manually set the voltage at which the op amp 280 and transistor actuate the vacuum switch relay 105 to correspond with the differential pressure at which it is desired to open the exterior door 64 (Figures 3 and 4). For example, if it is desired to open the exterior door 64 when the differential pressure is +10 torr, i.e., ambient pressure  $P_A$  is 10 torr less than load lock pressure  $P_L$ , the set point adjustment 284 can be set manually to make that result. The hysteresis adjustment 285 in conjunction with the hysteresis circuit IC 286 set a range from the set point differential pressure in which the op amp 280 and transistor 282 will not reverse a relay control signal to the atmospheric switch relay 105. For example, if the set point for the atmospheric switch relay 105 to open the exterior door 64 is -10 torr, then the hysteresis adjustment can be set so that the atmospheric switch relay 105 holds that state until the pressure differential rises to -5 torr. This feature prevents the op amp 280 and transistor 282 from dithering and chattering the atmospheric relay switch rapidly on and off. --